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STANDING MEDICAL ADVISORY COMMITTEE

Staphylococcal Infections in Hospitals

Report of the Sub-Committee

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STANDING MEDICAL ADVISORY COMMITTEE

SUB-COMMITTEE ON STAPHYLOCOCCAL INFECTIONS IN HOSPITALS

THE CONTROL OF STAPHYLOCOCCAL INFECTIONS IN HOSPITALS

OBJECTS OF THIS REPORT

The objects of this report are to draw attention to the prevalence of staphylococcal disease in hospitals, to discuss the principles of prevention, to summarise accepted control measures and to indicate problems which need further study. The conclusions and recommendations are especially appropriate to hospitals where acute medical, surgical or obstetrical work is undertaken.

SUMMARY OF MAIN CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

1. The control of staphylococcal disease depends largely on the application of aseptic methods. The use of antibiotics, either for treatment or for prophylaxis, is by itself unreliable. (Paragraphs 46-48.)
2. Staphylococcal infection may give rise to disease in any department of a hospital. It is a particularly troublesome problem in surgical departments and maternity units. (Paragraphs 50-53.)
3. The extent of the problem may well be overlooked if there is no adequate system of recording or if appropriate facilities for bacteriological investigation are lacking. (Paragraph 54.)

DISCOVERING AND RECORDING CASES OF INFECTION

4. Continual vigilance is needed to detect clinical signs of infection in patients and staff. (Paragraphs 56, 57, 61.)
5. The progress of patients should be followed for long enough and with sufficient care to reveal any clinical evidence of infection which may occur. (Paragraphs 58, 59, 60, 68.)
6. The need for the voluntary reporting of minor ailments, including septic lesions of the skin, should be impressed on all members of the hospital staff. (Paragraph 61.)
7. In all cases of suspected staphylococcal disease it is desirable to confirm the diagnosis by bacteriological investigation. (Paragraph 62.)

8. Records of clinical evidence of infection should be maintained in a simple, comprehensive and readily available form. (Paragraphs 63-66.)

9. The maintenance of a Control of Infection Register (see Table II), or its equivalent, should normally be the responsibility of the nursing sister in charge of the ward or department concerned. (Paragraph 67.)

10. Clinicians should accept the responsibility of examining regularly the registers of the wards or departments where their patients are treated. (Paragraph 67.)

11. It is essential to have one person responsible for reviewing the infection records of the entire hospital. This would normally be the hospital's Control of Infection Officer. (Paragraphs 69, 70.)

SOURCES OF INFECTION AND MODES OF SPREAD

12. The sources of staphylococcal infection are to be found in human tissues where staphylococci are multiplying, either in septic lesions or at healthy carrier sites. (Paragraphs 71-73.)

13. Transference of infection may take place directly from person to person, either by contact or by air-borne droplets, or indirectly by way of contaminated articles or air-borne dust. (Paragraphs 74-80.)

14. Staphylococci are moderately resistant to drying and remain viable for considerable periods after their release from the host tissues. Most of the inanimate objects in the hospital environment may act as depots for these organisms. (Paragraphs 74, 81, 82, 83.)

PRINCIPLES OF PREVENTION

15. It is important to allow adequate space for the patients' beds and enough time for the staff to carry out the preventive measures which are needed. (Paragraphs 85, 86.)

16. The control of sources of infection may be hindered by the widespread, or indiscriminate, use of antibiotics. Clinicians should be prepared to consider certain voluntary restrictions of the use of these drugs. (Paragraphs 87-90.)

17. Patients should be protected from exposure to risks of infection. (Paragraphs 91, 97, 98, 99, 101.)

18. The dispersal of organisms from contaminated dressings, clothing, bedding and dust should be kept to a minimum. (Paragraphs 92-96.)

19. Wounds should ideally be dressed in properly designed treatment rooms. (Paragraph 98.)

20. Staff exposed to risk of infection should be protected by the wearing of gloves, gowns and masks or other protective clothing. (Paragraph 100.)

21. Particular attention should be directed to the proper disposal of articles removed from a heavily contaminated environment. These should be dealt with by incineration, sterilisation or disinfection. (Paragraphs 102, 103, 106, 107.)

22. The hazards of air-borne contamination can be reduced by controlled ventilation. There is insufficient evidence of the value of irradiation by ultra-violet light as a means of reducing the bacterial content of air. (Paragraphs 105, 108.)

23. Clean or sterile articles should be protected from contamination. (Paragraph 104.)

PRACTICAL DETAILS OF SOME PREVENTIVE MEASURES

24. Patients with septic lesions should, preferably, be isolated in single rooms. A less satisfactory alternative is the segregation of such patients in multi-bedded "septic" wards. (Paragraph 111.)

25. Single rooms should be available for the isolation of members of the staff with septic lesions. (Paragraph 111.)

26. Ancillary rooms should be planned with due attention to the need for protecting clean or sterile materials from contamination. (Paragraph 113.)

27. Washing facilities should be readily available in all situations where they are likely to be needed. (Paragraph 115.)

28. Supplies of equipment needed for the maintenance of effective preventive measures must be adequate for the purpose. (Paragraph 116.)

29. Isolation nursing techniques should be employed in the treatment of patients with septic lesions. (Paragraph 121.)

30. Techniques which incorporate some of the principles of isolation nursing should be applied to the nursing of infants. (Paragraphs 122-125.)

31. Operating theatre practices should be designed to reduce risks of infection. (Paragraph 129.)

32. The use of gloves, masks and gowns is advocated in a variety of circumstances. (Paragraphs 130-133.)

33. All members of the staff in attendance on patients should wash their hands before and after each item of service. (Paragraphs 134, 135.)

34. Blankets should be regularly disinfected. (Paragraphs 137, 138.)

35. Mattresses should be either regularly disinfected or protected from contamination by an impermeable cover. (Paragraph 139.)

36. The disposal of soiled, fouled or infected linen should conform to the recommendations of the Central Health Services Council's Committee on Hospital Laundry Arrangements. (Paragraphs 140, 141.)

37. Effective methods of disinfection or sterilisation should be practised. (Paragraph 142.)

CONTROL OF OUTBREAKS

38. The control of outbreaks may call for a variety of additional methods of investigation and prevention. (Paragraphs 144-157.)

ADMINISTRATIVE CONSIDERATIONS

39. The hospital Control of Infection Officer occupies a key position in the co-ordination of regular preventive measures and the control of outbreaks. (Paragraphs 159-161.)

40. Other senior members of the hospital staff must also co-operate in the prevention of infection and the training and supervision of those concerned. (Paragraphs 162-166.)

41. The hospital Control of Infection Committee should meet regularly to review the sepsis record. (Paragraphs 167, 168.)

42. The Hospital Management Committee or Board of Governors should ensure that adequate arrangements are made to control hospital infection. (Paragraphs 171, 172.)

43. The Board of Governors of a Teaching Hospital may wish to consider the additional problems associated with the presence of medical students. (Paragraph 173.)

44. Regional Hospital Boards should make themselves generally familiar with arrangements in their Regions and ensure that liaison is maintained with central and local authorities who have an interest. (Paragraphs 174-175.)

45. It is important to maintain adequate liaison both within the hospital and with relevant agencies outside it. Greater collaboration between hospitals, general practitioners and local authority services is highly desirable. (Paragraphs 174-177.)

I. INTRODUCTION

46. The prevalence of staphylococcal infections in hospitals is giving rise to growing concern. The fact that such infections continue to occur, in spite of increased understanding of the measures necessary for their control, may be attributed to various causes. During recent years much attention has been directed to the associated problem of resistance of staphylococci to the action of antibiotics. Many strains of staphylococci can withstand the action of an antibiotic either by their ability to grow in the presence of the drug or, as in the case of penicillin, by the production of a specific drug-destructive enzyme. Experience has shown that the continued use of any antibiotic in a hospital community is accompanied by the emergence of staphylococcal strains against which the drug in question is powerless to act. Penicillin, in particular, now meets with limited success in the control of staphylococcal sepsis.

47. Drug resistance would be serious enough if it resulted only in failure to suppress staphylococcal disease. There is evidence, however, that morbidity from staphylococcal infection may even be enhanced by the use of antibiotics. This may arise in at least two ways: by the selective encouragement in hospital communities of resistant strains of high infectivity or virulence; or by the elimination from individual patients of other bacteria in a competitive flora. The first of these may explain the emergence of certain highly virulent types of staphylococci, such as phage type 80; the second is probably an important factor in causing staphylococcal diarrhoea during oral antibiotic therapy.

48. The wide distribution of antibiotic resistant staphylococci has introduced a new and disturbing element into the field of hospital infections. This should not, however, be allowed to divert attention from the fact that staphylococcal disease was a major hospital problem long before the antibiotic era. The early promise, which the antibiotics seemed to give, of increased protection against the effects of staphylococcal infection has not been fulfilled. The failure may in part be remedied by the more careful use of antibiotics, but this alone will not

suffice. The essence of the problem remains unchanged, namely, to prevent infection by the application of aseptic methods.

49. The developments outlined above have led to a revival of interest in the principles and practice of asepsis. Many investigators have contributed to our knowledge of the sources and modes of spread of staphylococci and of the value of some of the measures advocated for their control. The sub-committee considers that the time is opportune to review accepted practices and recent advances in this field. The objects of this interim report are to reiterate the principles of prevention of infection, to set out those practical measures the value of which has been firmly established and to indicate those subjects of which more knowledge is needed before further detailed recommendations can be made with confidence.

GENERAL SURVEY OF STAPHYLOCOCCAL DISEASE IN HOSPITALS

50. Potentially pathogenic strains of staphylococci are to be found so commonly in the general population, and particularly in hospital communities, as to justify the term "ubiquitous" which has so often been applied to them. Transference of such organisms from person to person may take place without the production of clinically recognisable lesions. It is not until colonisation of a susceptible individual, or implantation into a vulnerable site, has occurred that a problem of disease, as distinct from infection, will arise. For this reason there are certain departments of hospitals where the different forms of staphylococcal disease are likely to prove most troublesome.

51. Skin sepsis, for example, may occur at any age but is of paramount importance during the neonatal period and constitutes a major hazard only in maternity units. Other forms of staphylococcal disease found mainly in maternity units include suppurative of the infant's eye, the umbilical stump or the mother's breast. Sepsis of wounds and burns is found mainly in surgical departments. Respiratory illnesses may occur in medical, paediatric, surgical, or maternity wards, either as a result of primary staphylococcal infection or as a complication of a respiratory virus disease such as influenza. Enteritis associated with the oral administration of antibiotics may be observed in both medical and surgical wards. Genito-urinary tract infections occur usually in surgical or gynaecological wards.

52. Table 1 sets out the common anatomical sites of staphylococcal infection and the nature of the lesions which may result. From any one of these sites extension of the infective process may take place to adjacent tissues or into the blood stream, giving rise to conditions such as cellulitis, empyema, peritonitis, pyaemia, septicaemia, endocarditis and meningitis. Many localised staphylococcal lesions are trivial in themselves but, by acting as sources of infection to others, they form the background to these more serious illnesses which may well prove fatal.

53. Divergent opinions have been expressed about the prevalence of staphylococcal disease partly, perhaps, through failure to discriminate between the incidence of infection, in the bacteriological sense of the word, and the incidence of clinical sepsis. The clinical manifestations of staphylococcal infection vary widely in their severity, and figures for sepsis rates, therefore, need to be interpreted in terms of the clinical criteria which have been adopted. In surgical practice the occurrence of frankly purulent discharge from an initially

clean operation wound is commonly classified as serious sepsis. The incidence of this is by no means negligible. A figure of 5 per cent. is not uncommon and rates of more than 10 per cent. have been recorded. Serious sepsis in maternity units is perhaps less frequent, though the incidence of minor lesions of the skin or eyes may be high. Minor sepsis rates of 5 per cent. to 20 per cent. are not exceptional.

54. Such observations leave little doubt that a sizeable problem of staphylococcal disease exists, though it may well be overlooked if a hospital has no adequate system of recording or if appropriate facilities for bacteriological investigation are lacking. In this context it may be relevant to quote the experience of Ravenholt and La Veck¹, in the course of investigations in one of the western United States, that " staphylococcal disease is a major problem in the better hospitals—the ones which have pathologists and good laboratories and a hospital-infection record keeping system. Administrators of hospitals without such resources usually stated that they had no staphylococcal disease problem ". Information supplied to the sub-committee suggests that this problem is indeed causing concern in many hospitals in Great Britain. It is also certain that no scheme for the control of staphylococcal infection is likely to prove effective in the absence of detailed knowledge of its incidence.

TABLE I
COMMON SITES OF STAPHYLOCOCCAL INFECTION

<i>Site of Infection</i>					<i>Nature of Lesion</i>
*Skin	...	...	...	...	Furunculosis Impetigo. Pemphigus neonatorum. Other pustular eruptions.
Breast	...	...	...	...	Abscess. Cellulitis.
*Umbilical stump	...	...	...	...	Suppuration.
Wounds	...	...	...	...	Sepsis.
Burns	...	...	...	...	Sepsis.
Eye	...	...	...	...	Conjunctivitis. Ophthalmia neonatorum.
Ear	...	...	...	...	Otitis externa. Otitis media.
*Nose	...	...	...	...	Furunculosis.
Respiratory tract	...	...	...	...	Sinusitis. Pharyngitis. Laryngitis. Tracheitis. Bronchitis. Pneumonia. Lung Abscess.
*Intestinal tract	...	...	...	...	Post-therapeutic diarrhoea.
Genito-urinary tract	...	...	...	...	Urethritis. Cystitis. Pyelitis.

* These are also common healthy carrier sites.

II. DISCOVERING AND RECORDING CASES OF INFECTION ("ASCERTAINMENT")

55. Awareness of the existence of staphylococcal or other infections is dependent on the measures adopted to detect and record them. Those hospital authorities which have recognised the importance of achieving a high degree of ascertainment have established systematic procedures to this end but, in general, methods for the collection of the necessary information have received scant attention and surprisingly little has been published on the subject. Some of the problems involved have been discussed by Jeffrey and Sklaroff² in a paper, dealing with the incidence of wound infection, to which further reference will be made in this section.

56. For ordinary purposes what is needed is continual observation, both of patients and of staff, for clinical signs of infection and the maintenance of accurate records of the findings. The present report is concerned specifically with staphylococcal infections but it is evident that disease caused by other organisms will also enter into the same set of primary observations and records. The object is to enable the responsible hospital authority to have information about the incidence of clinically recognisable infections readily available at all times. This information forms the necessary background to any scheme of control. It is needed:

- (a) to assess the efficacy of the regular preventive measures in use in the hospital;
- (b) to recognise, by any unusual level or change in level of incidence, the existence or impending spread of an outbreak; and
- (c) to judge the desirability of introducing special measures to control an outbreak, or threatened outbreak, and to assess the efficacy of such measures.

If the purposes for which the information is required are kept clearly in mind, the detailed procedures for its collection in a particular hospital are best determined by those who know the local circumstances. Nevertheless, certain principles have a fairly general application and these are set out in the remainder of this section.

THE PATIENT IN HOSPITAL

57. The clinical supervision of the progress of a patient in hospital, which is the direct responsibility of medically qualified members of the staff, should include examination for evidence of intercurrent infection. In certain circumstances part of this function can justifiably be delegated to members of the nursing staff who may, in the course of their routine duties, be in a better position to observe the earliest signs of infection. The dressing of surgical wounds is commonly undertaken by nurses and it is the dresser's responsibility to look for wound sepsis. Similarly, in maternity units the nursing staff, when attending to the toilet of their patients, should watch the infants for septic lesions of the eyes, skin or umbilicus and the mothers for lesions of the nipples, breasts or perineum. In all cases the nurse should record the facts and bring any evidence of infection which she may have observed to the notice of the ward sister who, in turn, should inform the clinician in charge of the patient, so that appropriate therapeutic and preventive action can be taken.

THE PATIENT AFTER DISCHARGE

58. It is not uncommon for the clinical effects of infection acquired in hospital to be delayed until after the patient has been discharged. Jeffrey and Sklaroff² have drawn attention to the need for ensuring that surgical wounds are followed up for long enough and with sufficient care to reveal any evidence of sepsis which may occur. Whenever a surgical patient is discharged from hospital, or transferred to a convalescent home, it is important that clinical supervision should continue until all wounds have completely healed and no further likelihood of development of sepsis exists.

59. The same argument applies with particular force to the ascertainment of cases of mastitis or breast abscess among mothers delivered in hospital. Maternal breast abscesses may develop several weeks after discharge from hospital, though the source of infection may have lain in the maternity unit. Fulton³ found that mastitis occurred much more commonly among women delivered in hospital than among those who were confined in their own homes. In his series of 121 cases of mastitis among women delivered in hospital the onset of the disease was later than the 14th day of the puerperium in no less than 90 per cent. Reports of recent outbreaks of staphylococcal infection in maternity hospitals⁴ have confirmed the late onset of most breast abscesses.

60. The adequate follow-up of patients after discharge from hospital introduces certain administrative considerations which are discussed in section 7 of this report.

STAFF

61. It should be impressed on all members of the staff—medical, nursing, auxiliary and domestic—that they should report any minor ailment, including septic lesions of the skin, however trivial. Staff when on duty would normally report, in the first instance, to the person in charge of the department in which they are working. This person should refer for a medical opinion any member of the staff thought to be suffering from an infection. It is on voluntary reporting that the detection of clinical evidence of infection among members of the staff depends and their attention should be drawn to this at regular intervals.

BACTERIOLOGICAL INVESTIGATIONS

62. In all cases of suspected staphylococcal disease it is desirable to confirm the diagnosis by the bacteriological investigation of appropriate specimens. In ordinary circumstances staphylococci can be recognised by their cultural appearance, and the coagulase test used as an index of potential pathogenicity. Type identification is not normally required except in the investigation of an outbreak. It is, however, highly desirable that hospital laboratories should keep strains of staphylococci for at least three months, in case the need for type identification should later arise. The investigation of an outbreak may be greatly hampered in its early stages if staphylococcal strains, isolated before the outbreak began, have been discarded.

RECORDS

63. When clinical evidence of infection, either of a patient or of a member of the staff, has been observed, a record of it should be entered in the individual's

case-notes. The information contained in these, however, is not accessible enough to provide a ready means of estimating the incidence of staphylococcal or other disease throughout a hospital. For this purpose a separate set of records is needed—simple, comprehensive and readily available.

64. The minimum relevant information consists of the identity of the individual, the nature of the lesion and the date on which the lesion was first observed. It is also desirable to indicate whether or not specimens were taken for bacteriological investigation. A record of this information should be kept in every ward, or group of wards, in casualty and out-patient departments and in staff sick-quarters. In surgical, maternity and paediatric wards it is desirable to keep fuller records than elsewhere and an entry should be made for each patient, whether clinical signs of infection develop or not. Such a record is more likely to be complete and readily available than one which is restricted solely to notes on patients found to have become infected.

65. The precise form in which these records are maintained is of less importance than their content, but a well-run system simplifies the task of collation. For the ward unit a book is probably better than loose-leaf notes. This may be termed the "wound book", "sepsis book" or "control of infection register." A suggested lay-out suitable for use in surgical wards is shown in Table II. With appropriate modifications a similar lay-out can be used in maternity or paediatric wards.

66. As an alternative to the maintenance of a separate Register it may be found convenient to adapt the ward Admission and Discharge Book by including extra columns for the necessary information. Similar additions can be made to Casualty or Out-Patient Registers and to Staff Sickness Registers. If this alternative is adopted, notification of cases of infection will need to be made on a separate form.

67. The nursing sister in charge of a department or ward unit is usually the most suitable person to keep the Control of Infection Register or its equivalent. This has obvious advantages when more than one clinician is responsible for patients under treatment in the unit. Appropriate entries should be made as soon as possible after definite signs of infection of a patient have been observed. Findings recorded at the time of observation are likely to prove more reliable than entries made retrospectively. To simplify current recording it may be helpful to the ward sister, in the course of her rounds, to mark the condition of a patient or the state of a wound, as suggested by Jeffrey and Sklaroff², by means of a symbol on the patient's temperature chart. It should be emphasised that the keeping of records is not an end in itself; the information contained in them should be examined regularly by the clinician in charge.

68. The maintenance of Control of Infection Registers will meet the requirements of ascertainment so long as the patients remain under treatment in the same hospital. More is needed if the process is to continue, as it should, after their discharge or transfer. For this purpose some kind of follow-up record is indicated. The system to be used will depend on whether the patient remains under the care of the same hospital authority or comes under the supervision of outside agencies. It may prove helpful to adopt an all-purpose form of follow-up record, suitably adapted to the type of patient concerned. This could accompany the case notes for subsequent completion by the clinician in charge.

COLLATION OF INFORMATION

69. It is essential to have one person responsible for scrutinising all hospital sepsis records. This would normally be the Control of Infection Officer, to whom executive functions have been delegated by the Control of Infection Committee, as recommended in the Procedural Memoranda for Hospitals⁷ prepared by the Standing Nursing Advisory Committee.

70. The status and functions of the Control of Infection Officer are dealt with in section 7 of this report. It is he who should see that the Control of Infection Registers are maintained and that the information recorded in them is collated and brought to the notice of his colleagues and of the appropriate hospital officers or committees. In this context two distinct needs arise:

- (a) for a general summary of the levels of clinical infection in the various wards and departments of a hospital,
- (b) for a specific report in the event of an outbreak or threatened outbreak.

TABLE II

Hospital Refer- ence No.	Patient's name	Date admitted	Surgeon in charge	Diagnosis	Date of operation	Evidence of infection	Date observed	Bacterio- logical investi- gations	Date dis- charged

Suggested lay-out of Control of Infection Register for use in surgical wards.

III. SOURCES OF INFECTION AND MODES OF SPREAD

71. In the extensive literature which has been devoted to the subject of hospital infections, the term "source of infection" has been commonly applied not only to sites where micro-organisms are multiplying but also to inanimate objects contaminated with such organisms and even to the air of the operating theatres or wards. The word "reservoir" has also been used, with the same broad connotation, as synonymous with source. These usages differ somewhat from the meanings which are attached to the words "source" and "reservoir" in general epidemiological studies. While this may seldom give rise to ambiguity, when taken in the appropriate context, it is worth preserving the distinction between a "source" of infection, such as a septic lesion or a persistent nasal carrier, where organisms are multiplying, and a "depot" of infection, such as a contaminated utensil or transient skin carrier, which acts merely as a resting-place or a vehicle for viable organisms. It is unfortunate, for example, by using the phrase "source of infection" in its broader sense to convey the impression that staphylococci commonly proliferate in floor dust, though it is within the experience of members of the sub-committee that conclusions of this kind have been loosely accepted in some hospitals. Such a belief is likely to result in false emphasis on the relative merits of different measures of control. For this reason, while admitting the possibility that pathogenic staphylococci may occasionally multiply under favourable conditions on inanimate objects, it is proposed in the present section of this report to restrict the use of the term "source of infection" to sites of multiplication in living tissue.

SOURCES OF INFECTION

72. For practical purposes animal reservoirs of infection may be ignored in any consideration of staphylococcal infections in hospitals. The sources, therefore, can be accepted as existing in human tissues. These may be classified into two main categories:

- (a) Septic lesions
- (b) Sites of inapparent infection
 - (i) associated with subclinical wound infections
 - (ii) in healthy carriers, e.g. in the nasal passages.

73. The principal septic lesions associated with staphylococcal infections have already been set out in Table I of the introduction to this report. The tissues in which these lesions occur—skin, breast, umbilical stump, wounds, burns, eye, ear, nose, the respiratory, intestinal and genito-urinary tracts—may also be the seat of inapparent infections. The length of time for which pathogenic organisms may persist during convalescence from staphylococcal disease or following inapparent infection is highly variable. The duration of the healthy carrier state also varies. Some persons appear to carry staphylococci in their nasal passages indefinitely; others carry them intermittently for a few days or weeks⁶. The persistent carriers commonly carry one strain for long periods; the intermittent carriers carry different strains from time to time. The sites of election for the multiplication of staphylococci in persistent healthy carriers are

the anterior nares, the intestine and certain areas of the skin, such as the perineum⁷.

TRANSFERENCE OF INFECTION

74. Transference of organisms may occur from the source of infection to another site on the same individual (self-infection) or to another individual (cross-infection). In either instance the mode of transmission may be direct or indirect. Since staphylococci are moderately resistant to drying and retain their viability for considerable periods after their release from the host, transmission can follow a variety of routes. The possibilities, in their barest essentials, are represented schematically in Figure 1 and will be examined in more detail later in this section.

75. Many factors are concerned in determining both the availability of routes for the spread of staphylococci and their chances of successful colonisation at a new site. In spite of the very considerable amount of research that has been devoted to the problem it is still not possible to define all the factors or to estimate precisely the relative importance of those which are known to be operative. The liability for clinical infection to develop after transference of staphylococci to a new site is dependent partly on the virulence of the strain, partly on the susceptibility of the recipient host tissue and partly on the number of viable organisms transferred. It is this quantitative aspect that introduces a complexity to the problem which can be satisfactorily resolved only by a judicious combination of clinical observation and bacteriological investigation. Shooter et al.⁸, in a detailed study of the spread of staphylococci in a surgical ward, recognised some 186 different types of these organisms, but only 13 of them caused disease and only 3 were responsible for disease in more than one patient. This illustrates the need to relate bacteriological findings to known cases of disease.

VIRULENCE OF STAPHYLOCOCCI

76. The coagulase test is the most useful laboratory criterion of pathogenicity of staphylococci and it is wise to regard all coagulase-positive staphylococci as potentially pathogenic. Experience of the last few years shows, however, that some coagulase-positive strains have a greater capacity for producing sepsis, and for causing epidemics in hospitals, than others. Unfortunately no laboratory test is yet available for distinguishing the more virulent strains; they can only be recognized with certainty as such when they have produced sepsis, or epidemics. A few phage types are particularly prone to be virulent, but the correlation of virulence with phage type is not close enough to justify typing for predicting virulence.

DISPERSAL OF ORGANISMS FROM THEIR SOURCE

77. The number of organisms available for transference to a new site is dependent partly on the number present at their source and partly on the ease with which they can be dispersed. An abundant discharge of pus from a septic lesion provides a large number of organisms at the source. It is evident that any such lesion constitutes a major hazard to other persons in the environment and necessitates the adoption of measures to limit dispersal. The degree

to which dispersal does occur, either under natural or controlled conditions, will depend on the site and nature of the lesion and the control measures employed. For this reason some lesions are potentially more dangerous as sources of infection than others. A septic wound, for example, if adequately covered, may be rendered relatively harmless to other persons by the use of careful dressing techniques in a properly designed treatment room, whereas the presence in an open ward of a patient suffering from a staphylococcal lung abscess may create a situation which can only be met by removal of the patient to isolation accommodation.

78. Although some septic lesions can be recognised as potentially more dangerous as sources of infection than others, the degree of dispersal of organisms from them is not always predictable on clinical grounds. Similarly, healthy carriers vary greatly in their ability to disperse staphylococci from the nose, faeces or skin into their environment. The investigations of Duguid and Wallace⁹ and of Hare and his co-workers^{7, 10} have done much to elucidate the mechanisms concerned and to demonstrate the importance of indirect as well as of direct routes of dispersal. The first step in the indirect transference of staphylococci from their source is usually by contamination of the skin and clothing of the carrier. The organisms may then be transmitted by contact to other persons or to objects, such as bedding or towels, or by air-borne particles or dust released from the skin or clothing. Hare and Ridley⁷ have shown that bodily movement facilitates dispersal of air-borne particles and that other factors, such as the time elapsing since the last bath or change of underwear, are also of importance. The practical application of such studies is to be looked for in the design of measures to control dispersal of staphylococci, both from cases and carriers, and in the recognition of the fact that individuals harbouring potentially pathogenic organisms vary widely in their propensity for releasing them to their environment.

SUSCEPTIBILITY OF HOST TISSUES

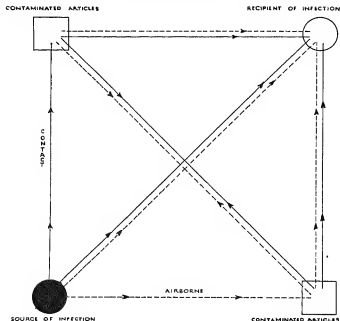
79. Just as some persons and some lesions constitute particular hazards as sources of infection, so some persons and some tissues are exceptionally vulnerable to attack, and when both co-exist in circumstances favourable to transmission the risk of cross-infection may be greatly increased. Young infants are at special risk. So, also, are persons of any age who are under treatment in hospital with broad-spectrum antibiotics and those in the acute stage of certain virus infections, such as influenza or measles, in whom staphylococcal pneumonia may prove a fatal complication.

80. The vulnerability of tissues in otherwise healthy persons is enhanced by trauma. Excoriation of the skin forms an important predisposing factor, for example, in the development of pemphigus neonatorum. Surgical wounds are particularly prone to staphylococcal infection. The adverse influence of the presence of foreign body reactions in wounds has long been recognised on clinical grounds and has recently¹¹ been the subject of experimental confirmation.

MODES OF SPREAD

81. Direct transmission from person to person (see fig. 1), either by contact or by air-borne droplets, may not be a common mode of spread but, when it occurs, may have potent effects. Examples of direct transmission are: by

FIGURE 1

Scheme to illustrate Spread of Staphylococcal Infection

contact of a septic lesion of the finger of a nurse with a patient's wound or by air-borne droplets from a lung abscess expelled by coughing.

82. Indirect transmission by way of contaminated articles is much the commoner mode of spread. The greatest hazard comes from articles which have been closest to the source of infection, such as the dressings from septic wounds, the instruments which have been used for dressing them and the gloves or fingers of the attendants.

83. Most of the inanimate objects in the hospital environment may act as depots for staphylococci. These include articles of clothing, handkerchiefs, toilet articles, crockery and cutlery, thermometers, sputum containers, bedpans, urinals, sheets, blankets and other bed coverings, pillows, mattresses, bedsteads, bed curtains, screens, other ward furniture and accessories, examination or treatment couches, walls, floors, baths, wash basins, sluices and water closets. These objects may become contaminated either by contact with the source of infection or by air-borne droplets. They may in turn pass their contamination to persons or to other inanimate objects, in either case by contact

or by means of air-borne particles or dust. The essence of effective control measures is to break the important links in these chains of infection at as many points as may be practicable.

IV. PRINCIPLES OF PREVENTION

84. The principles underlying the various measures, which have been recommended for the prevention of staphylococcal infection, may be classified as follows:

- (a) provision of adequate accommodation and staff;
- (b) treatment of sources of infection;
- (c) segregation of sources of infection;
- (d) limitation of the dispersal of organisms from their sources or depots;
- (e) protection of susceptible persons and of vulnerable sites;
- (f) prevention of contamination of the environment, including the protection of clean or sterile articles;
- (g) decontamination of the environment, including disinfection or sterilisation of equipment.

The effective application of these principles depends on their combination in a balanced scheme of control.

PROVISION OF ADEQUATE ACCOMMODATION AND STAFF

85. Important practical requirements for the prevention of hospital infection are adequate space for the patients' beds and facilities for isolation. It is equally important to allow enough time for the staff to carry out the preventive measures which are needed. The aggregation of susceptible persons within a hospital results in an increased risk of exposure to infection and undue congestion, either in space or in time, enhances this risk. It is necessary, therefore, to ensure that the accommodation is sufficient for the number of patients who are to be admitted, and that the staff is adequate both in number and training. Conversely, every effort should be made to keep the rate of admission of patients at a level appropriate to the accommodation and staff available. This precaution is especially desirable when it is known that cases of infection are occurring.

86. Overcrowding of patients may militate against a satisfactory turnover by prolonging the stay of those who become infected or by the closure of wards as the result of outbreaks. The practice of "lodging" patients temporarily in hospital wards, in order to clear beds in wards elsewhere in the hospital, has obvious dangers and should be adopted only when circumstances make it essential and with adequate precautions against spread of infection.

TREATMENT OF SOURCES OF INFECTION

87. The prompt treatment of staphylococcal lesions reduces their period of infectivity. Resistance to antibiotics is one of the chief obstacles to the achievement of satisfactory results. As part of this problem has developed from the

widespread, and possibly indiscriminate, use of antibiotics, clinicians should be prepared to consider certain voluntary restrictions:

- (a) to keep certain antibiotics (e.g. erythromycin) in reserve, for the treatment of patients infected by organisms resistant to the drugs more commonly used;
- (b) to limit the authority to prescribe reserved antibiotics, except in emergency, to senior members of the medical staff and to consider the desirability of withholding the administration of such antibiotics until the results of sensitivity tests are known;
- (c) to abandon the widespread use of antibiotics for non-specific prophylaxis; attempts at prophylaxis in surgical practice frequently fail in their object because the drug used proves to be ineffective against the organisms which gain entry to the wound and continued prophylactic use of an antibiotic in a hospital helps to increase the load of resistant strains. There are, of course, special circumstances in which prophylactic use is fully justified.

88. A special problem is that of members of hospital staff with recurrent staphylococcal lesions. Good response in such cases has been reported from the local application to the nose of antibiotic or disinfectant preparations. To achieve consistent results by these means it is essential to ensure that staphylococci from the nose are of the same type as those responsible for the lesions. Bacteriological investigations are therefore necessary before treatment is begun.

89. Treatment of healthy nasal carriers is usually unnecessary except in the presence of an outbreak. Gould¹³ has drawn attention to the advantages for this purpose of antibiotics, such as tyrothricin, neomycin, hacitracin or polymyxin, which are not normally used systemically for the treatment of serious sepsis, and of antibacterial substances, such as the propamides or the diguanides, which are designed primarily for external application. Favourable results have been reported from the use of neomycin-hacitracin ointment¹³ and of chlorhexidine with neomycin or hacitracin¹².

90. Jellard¹⁴ has drawn attention to the importance of the umbilical stump as a source of infection in maternity nurseries and has shown that the growth of organisms at this site is inhibited by the application of Triple Dye.

SEGREGATION OF SOURCES OF INFECTION

91. Members of the staff (medical, nursing or ancillary) with a staphylococcal lesion should not remain on duty where there are patients at risk. Patients with septic lesions should either be isolated in single rooms or segregated in special wards.

LIMITATION OF THE DISPERSAL OF ORGANISMS

92. The dispersal of organisms from a discharging staphylococcal lesion can be limited to a considerable extent by covering the lesion with an adequate dressing, though too much reliance should not be placed on this alone. Colebrook¹⁵ has pointed out that a profusely discharging lesion may saturate the full thickness of a dressing and allow the liberation of infective particles from its surface. It is during the changing of dressings that the greatest dispersal of

organisms from a lesion is liable to occur and the control of this is one of the main purposes of a good dressing technique.

93. The clothing and bedding of an infected patient are second only to soiled dressings as a means of dispersal of organisms. The bedding of other patients also may become secondary depots for further dispersal. This is at its height during bed-making and changing of linen. It can be reduced by treating the blankets with a suitable oil¹⁶ but regular sterilisation^{17, 18} is probably more satisfactory.

94. Cleaning activities in the ward and other movements, such as the drawing of bedside curtains, also disperse organisms from their resting places on the floor and elsewhere. For this reason the application of dust-laying oils to floors has been recommended¹⁴. Not all materials are suitable for this treatment, which is most satisfactory for wooden floors. The alternative to oiling is the frequent removal of dust by methods designed to minimise dispersal, e.g. damp dusting, piped suction or the use of vacuum cleaners provided with efficient air filters.

95. The most important means of dispersal into the air by staphylococcal carriers among the staff is from the everyday clothes or normal working uniform. This is not much reduced by the wearing of gowns over contaminated clothes. Simplification of nurses' uniforms so that clean garments may be worn each day and the use of washable aprons are matters that need further investigation.

96. In operating theatres or delivery rooms all staff should change their outer clothing for any open surgical or obstetric procedure and should wear special boots or over-shoes. Dispersal of organisms can also be limited by restricting the number of persons in the theatre to those performing some essential function and by reducing unnecessary movement of staff. Careful attention to this and to other aspects of theatre discipline lessens not only the dispersal of organisms¹⁹ but also the number of staff needed during operations.

PROTECTION OF SUSCEPTIBLE PERSONS AND VULNERABLE SITES

97. Patients who are undergoing treatment with an antibiotic reserved for resistant infections should preferably be isolated in single rooms.

98. Wounds should ideally be dressed in properly designed treatment rooms. If the dressing of wounds in an open ward is unavoidable it is best done at a time when there are few activities and no visitors. Disturbances such as the cleaning of floors and the drawing of bedside curtains should be completed at least 15 minutes before dressings begin. Care should be taken that only sterilised material comes into contact with a wound and the skin surrounding it.

99. Infants' toilet should conform as far as possible to a wound dressing technique. Particular care is needed in the nursing of premature infants.

100. Staff exposed to risk of infection should be protected by the wearing of gloves, gowns and masks or other protective clothing.

101. The possibility of the introduction of staphylococcal infection by visitors should be borne in mind in deciding where and when visiting is to be allowed. Visitors known to be suffering from an infection should not be permitted to enter the wards.

102. Any of the measures which tend to limit the dispersal of organisms from their sources will also lessen the contamination of the environment. The value of isolation in this context is that unavoidable contamination of the environment by infected persons can be restricted to a defined area, from which organisms can be prevented from spreading by the use of appropriate techniques.

103. Particular attention should be directed to the proper disposal of articles removed from a heavily contaminated environment. These should be placed in suitable containers and removed for disposal by a route that does not lead through places in which sterile materials are exposed. For example, soiled dressings should never be brought into a room where clean dressing trolleys are being prepared.

104. The Nuffield Provincial Hospitals Trust and University of Bristol's Investigation Team found²⁰, as a defect in the organisation of many hospitals, that clean and dirty work was allowed to proceed side by side. Every effort should be made to protect clean or sterile articles from contamination. The application of this principle to the work of hospital laundries has been recommended by the Committee on Hospital Laundry Arrangements²¹ set up by the Central Health Services Council. A working party of the Nuffield Provincial Hospitals Trust is considering the subject of Central Sterile Supplies in hospitals. A report on the provision of Central Syringe Services has been published²².

105. The hazards of air-borne contamination can be reduced by controlled ventilation. The common system of exhaust ventilation used in operating theatres and delivery rooms has been shown²³ to constitute a major risk, by drawing into the atmosphere infective particles from wards and corridors. In operating theatres, control of air-borne bacteria can best be achieved by positive pressure ventilation with filtered air. This subject is dealt with in a recent bulletin issued by the Ministry of Health and Department of Health for Scotland.²⁴ The ventilation of surgical dressing rooms should be controlled so that effluent air does not gain access to the wards.

DECONTAMINATION OF THE ENVIRONMENT

106. The general cleanliness of all parts of a hospital makes an important contribution to the prevention of infection. Contaminated articles should be dealt with by incineration, sterilisation or disinfection. Sterilisation by heat, whenever practicable, is to be preferred to chemical methods of disinfection.

107. The disinfection of articles used by a patient, or for the patient's treatment, has long been an established procedure in hospitals. Recent work^{17, 18, 25} has revealed a glaring omission in this respect by drawing attention to the hazards presented by patients' blankets and mattresses, which commonly undergo no process of disinfection for prolonged periods of time.

108. Further investigation is needed of the value of irradiation by ultra-violet light as a means of reducing the bacterial content of air. In the present state of knowledge the use of bactericidal aerosols cannot be recommended.

V. PRACTICAL DETAILS OF SOME PREVENTIVE MEASURES

109. The need for co-ordination of individual preventive measures and for their integration into the normal working life of the hospital introduces a complexity to the problem of control of infection that cannot be satisfactorily resolved by concentrating only on a few aspects of it. Because of the variety of routes by which staphylococci can spread, the application of any single preventive measure may not greatly affect the incidence of sepsis. A wide range of precautions is generally needed to do this. An ideal system of control is unlikely to be attained except in a few fortunately placed hospitals but it is the opinion of this sub-committee that much can be achieved, even under difficult conditions, by the intelligent use of existing resources.

ACCOMMODATION

110. In an open general ward the minimum distance between bed centres should be kept at 8 feet. This distance could with advantage be increased to 12 feet if multi-bedded wards are used for the segregation of patients with septic lesions.

111. A sufficient number of single rooms should be available for the isolation of patients and members of the staff with septic lesions. In new hospitals now being planned or built the proportion of single rooms available for all purposes is generally not less than 20 per cent. of the total beds, but a responsibility falls on existing hospitals to make the best provision they can. All single rooms should be provided with the necessary facilities for isolation nursing. The practice of including isolation beds, which it may be necessary to hold in reserve when empty, in the statistics of bed occupancy may have an adverse psychological effect in discouraging the reservation of adequate isolation accommodation. When isolation accommodation within a hospital proves to be inadequate, consideration should be given to the transfer of patients to other hospitals, e.g. infectious diseases hospitals, with the necessary facilities. Alternatively, patients with septic lesions may be segregated in multi-bedded "septic" wards, though this arrangement is less satisfactory than isolation in single rooms.

112. In maternity units further investigation is needed of the effectiveness of strict "rooming-in" of mothers and infants. There are arguments for and against the use of communal nurseries. From the point of view of infection there would seem to be no materially greater hazard to the infant in a communal nursery than to the infant at the mother's bedside in an open ward. In all circumstances attention should be given to adequate spacing and to facilities for isolation. A floor space of 30 square feet per cot should be allowed in all nurseries and this should be increased to 50 square feet per cot in premature baby nurseries.

113. In surgical units mechanically ventilated dressing rooms are desirable. Other ancillary rooms should be adequate in size for the purpose for which they are intended and planned with due attention to the need for protecting clean or sterile materials from contamination. Where existing ancillary rooms are inadequate in size or in lay-out, consideration should be given to structural

alterations even if this means encroaching on the general ward space and reducing the number of available beds.

114. In operating theatre suites separate rooms are needed in which members of the surgical and nursing staff can change their clothing. These should preferably include a shower or bath. Sterilising rooms should be separate from the theatre. Sluice rooms should be separated both from the theatre and from the sterilising room.

WASHING FACILITIES

115. It is essential that facilities for hand-washing are readily accessible in all situations where they are likely to be needed, both in open wards and in isolation accommodation. The taps of fixed wash-basins or scrubbing-up stalls should preferably be knee- or foot-operated. Where elbow-operated taps are in use, supervision of staff is needed to ensure that they are in fact operated with the elbows and not by hand. All taps should be inspected regularly and serviced as required in order to ensure that they are functioning correctly. An adequate supply of clean towels is essential. Automatic towel dispensers and paper towels have some advantages.

SUPPLIES

116. The supply of gloves, masks, gowns, instruments, bowls and other equipment needed for the maintenance of effective preventive measures must be adequate for the purpose intended. Shortage of supplies leads to short cuts in technique with added risks of infection. The stocks held in wards and operating theatres should be reviewed regularly, in consultation with the sister-in-charge, to ensure that needs can be met. Extra supplies should be available to meet temporary requirements.

ORGANISATION OF STAFF

117. Shortage of staff is one of the most serious hindrances to prevention of hospital infection. Work should be so organised as to make the best use of skilled staff.

118. Nurses and nursing orderlies should be trained in techniques for their own protection and the protection of patients from infection. No-touch techniques in surgical dressings serve the double purpose of protecting the patient and the dresser. In the dressing of septic wounds the wearing of a gown and mask may lessen the risk of development of a carrier state in the dresser.

119. The wearing of a gown will protect the clothing of the attendant from contamination during the handling of patients, bed-making and other procedures. Staff employed in cleaning baths, wash-basins, water-closets and other contaminated articles should wear intact rubber gloves for the purpose. Protective clothing should be worn by any member of the staff handling heavily contaminated materials.

120. A member of the staff who has been absent from duty owing to a staphylococcal infection should be seen by a doctor before returning to duty in order that he may ensure that the individual is unlikely, by a resumption of

normal activities, to prove a source of infection to patients or to other members of the staff. In cases of doubt the opinion of the hospital's Control of Infection Officer should be obtained. It should be remembered that even when clinical resolution of a staphylococcal lesion appears to be complete bacteriological evidence of continuing infection may still be found.

ISOLATION NURSING

121. Rules for isolation nursing are given in Appendix I to this report. These rules are applicable to patients with septic lesions isolated in single rooms or segregated in open "septic" wards.

NURSING OF INFANTS

122. Although there is not complete agreement among obstetricians concerning the desirability of "rooming-in" in single wards as a general principle, there can be little doubt that, for the new-born infant in a single bed ward, it provides a measure of protection from infection. At present few units are provided with even a reasonable number of single-bed wards or rooms where a mother can have her baby beside her at all times and take an active part in the care of her infant. Greater efforts will no doubt be made in the future to increase these facilities by new buildings or the adaptation of existing accommodation.

123. Under conditions now prevailing it should be possible to split up large maternity wards into smaller units, so that most infants may be nursed with their mothers without being exposed to the considerable hazards of infection in the larger wards. Nursery accommodation will be necessary for infants who may disturb the mothers, particularly at night, but use of such space should be made as infrequently as possible, to ensure that infection, should it occur, will be on a limited scale.

124. Overcrowding of maternity nurseries of whatever size must not be allowed in any circumstances, in order to reduce the risk of infection and to give the nursing staff adequate room to work. Each baby should have its own individual toilet articles and other equipment. The communal use of any article, particularly the bath, should be avoided as far as possible. Visiting should never be allowed in nurseries.

125. No matter whether infants are nursed in separate rooms, small ward units or in nurseries, their ultimate safety depends upon the discipline of the medical and nursing staff in carrying out the principles of isolation nursing when handling babies under any conditions.

DRESSING OF WOUNDS AND BURNS

126. Wounds and burns should be uncovered as infrequently as possible. Dressings should be changed no more often than is necessary. In general, clean surgical wounds need to be exposed for inspection only at the time of removal of clips or stitches.

127. Any delay which occurs during the changing of dressings increases the risk of exposure to infection. Temporary covering of a wound, while awaiting inspection by the surgeon, does not entirely obviate this increased risk.

128. Rules for the performance of wound dressings are given in Appendix II to this report.

OPERATING THEATRE PRACTICES

129. Suggestions for prevention of infection in operating theatres are given in Appendix III to this report. Aseptic precautions should of course also be observed in X-ray departments and elsewhere when operative manipulations (e.g. catheterisation) are performed.

GLOVES

130. The use of unpunctured gloves for surgical operations, both by the surgeon and the immediate assistants, is essential. The presence of even small punctures in gloves is an important hazard during surgical operations. All gloves should be tested for leaks by filling with air and immersing in water. Other methods, such as filling with water or filling with air and trying to detect a leak by holding near the face, are unreliable.

131. Gloves which are observed to have become punctured during the course of a surgical operation should be changed without delay.

MASKS

132. Masks should be worn for all isolation nursing procedures, surgical operations, deliveries, wound dressings, nursing of premature babies, preparing babies' feeds, performing spinal or thoracic punctures. They should be made either of 6 layers of muslin or of 2 layers with one impervious layer of paper or Cellophane inserted. Expendable paper masks are now available. The evidence for the usefulness of masks in maternity nurseries (other than premature babies' nurseries) is equivocal.

GOWNS

133. Gowns should be worn for all the procedures mentioned under masks and, also, in maternity nurseries.

HAND-WASHING

134. Washing does not sterilise the hands but it does effectively remove recent contamination from the skin. Further investigation is needed of the optimum length of time for hand-washing and of the value of disinfectant soaps or creams. In the present state of knowledge it would seem reasonable to prefer short periods of washing, undertaken as an invariable routine, to an occasional "long scrub".

135. It is recommended that surgeons should scrub-up for 5 minutes at the beginning of an operating list and wash again before each succeeding operation on the list. In the wards, all those in attendance on patients should wash before and after each item of service. The hands of the attendant should be washed between dressings, whether gloves are worn or not.

PREPARATION OF SKIN

136. For the preparation of the skin of patients before surgical operations a preliminary soap and water wash may be followed, when the patient is on the operating table, by the application of a suitable skin antiseptic. This is probably as effective as more elaborate methods, but the problem needs further study.

BLANKETS

137. Blankets should be laundered, at least with each change of occupant of a hospital bed or cot, by a process which effectively reduces the bacterial load which they carry. Blankets from a ward should not be taken into the clean part of an operating theatre suite.

138. So far as concerns control of infection woollen blankets have some disadvantages in hospital work. These arise not from any defect in use but from the damage to woollen fabrics which results from laundering or sterilisation by heat. We are informed that research is in progress to overcome this difficulty. It is necessary to consider whether any alternative material offers greater safety from risk of spread of infection without loss of the other benefits of wool. Certain cotton (or cotton and rayon) fabrics, e.g. Turkish towelling or cellular cotton weave, are said to be durable, warm and unaffected by laundering processes conducted at a temperature sufficiently high to kill staphylococci¹⁸. Gradual replacement of woollen blankets by one of these alternatives is advised, at least for surgical wards and obstetric units. Until such replacement can be made one of the special laundering processes¹⁷ which reduce the danger of woollen blankets harbouring staphylococci should be applied to them.

MATTRESSES

139. Further investigation is needed of foam rubber mattresses suitable for surface disinfection by chemical methods. In some hospitals mattresses are disinfected, either by heat or by formaldehyde vapour, on the discharge of each patient. As an alternative to the disinfection of the entire mattress the use of an impermeable Polythene cover has been advocated. This should be destroyed on the discharge of each occupant.

LINEN

140. Canvas bags on wheeled frames are recommended for collecting soiled linen at the bedside. Covered sanitary bins containing disinfectant fluid are needed for fouled or infected linen or clothing and for infants' napkins.

141. Hospital laundry arrangements have formed the subject of a recent report²¹ to the Central Health Services Council.

DISINFECTION AND STERILISATION

142. Attention is directed to the Report²⁶ of the Central Pathology Committee of the Ministry of Health on the Sterilisation of Hospital Equipment. We understand that reports on this subject will shortly be made by The Nuffield Provincial Hospitals Trust and by the Medical Research Council's Committee

on Control of Cross Infection. Sterilising equipment should be of satisfactory type, should be regularly inspected and kept in good order by the hospital engineer, and should be regularly tested by the hospital bacteriologist.

DISPOSAL OF CONTAMINATED DRESSINGS

143. Contaminated dressings should be placed in impervious paper containers and burned in a properly designed incinerator.

VI. CONTROL OF OUTBREAKS

144. Routine records of the level of sepsis can be compared with those of other hospitals and will often indicate changes in prevalence that may presage a definite outbreak. The Control of Infection Committee of any hospital should have its own defined plan as to what change in prevalence brings into play the special investigations suggested below. This might be doubling of the sepsis rate, or increase by a given percentage.

145. One of the chief difficulties in controlling outbreaks has often been that they have gone on too long uninvestigated. A pre-arranged indication for further investigations should help to overcome this. Not all hospital laboratories are or can be fully equipped for extensive bacteriological investigations. The need to seek help or consultation with the Medical Officer of Health or Public Health Laboratory Service should not be regarded as an adverse reflection on the hospital, but simply as the rational use of specialist advice and facilities. Whereas the routine sepsis record would normally be based on clinical observations only, in face of an outbreak it must be made bacteriological as well. The staphylococci from the lesions should be submitted for type identification.

EPIDEMIOLOGICAL AND BACTERIOLOGICAL INVESTIGATIONS

146. When an outbreak of staphylococcal infection occurs, the first action should be to make a list of the patients thought to be involved. This list should include:

Name, sex, ward; primary diagnosis.

Date of onset of sepsis and its nature.

Type of staphylococcus.

Any special treatment given.

For surgical wounds: date of operation; operating theatre and surgical team; date of any post-operative wound dressing before appearance of sepsis; name(s) of dresser(s).

For mothers and infants: date of delivery; labour ward; midwife.

147. The epidemiological analysis should indicate one or more places (or times) in which the patients could have become infected. If most cases of sepsis develop soon after operation (and especially if before the first post-operative

dressing), with pus in the depths of the wound, introduction of infection in the operating theatre should be suspected. It may be that one surgical team, or one surgeon in a team, has more patients who become infected than the others using the same theatre; or it may be that one operating theatre appears more dangerous than others used by the same team.

148. The bacteriological investigations should show whether the patients are infected by many different phage types, or by one phage type of staphylococcus only. In any large epidemic it will be rare for all the patients to be infected by a single type, but a clear predominance of one type should in these circumstances justify concentration on that type at first.

INFECTIONS DUE TO SEVERAL PHAGE TYPES OF STAPHYLOCOCCI

149. The presence of several different types among the patients infected in a staphylococcus outbreak indicates that the pathways from many sources of infection are open. From the preliminary epidemiological listing it should be possible to decide whether the operating theatre is likely to be the point at which the sources of infection are impinging on the patient. If this is the case, investigation should be made of the ventilation of the theatre and of the general hygienic precautions there, with special attention to the clothing of the staff and the possibility that ward blankets etc. are brought in with the patient.

150. A variety of types responsible for infections apparently introduced in the ward probably indicates a defective aseptic routine for dressings there; the techniques used and the facilities available should be reviewed.

151. One other reason for infection of wounds by a variety of types, though one unlikely to lead to an epidemic, is self-infection from carrier sites on the patient himself. In acute surgical wards, this is likely to result in a proportion of infections due to antibiotic-sensitive staphylococci, but in long-stay hospitals the patients may become carriers of the drug-resistant hospital strains before operation and then become infected by them.

SINGLE PHAGE TYPE EPIDEMICS

152. The dominance of one type may indicate that the patients are all infected from one source, or that a single type has become so widespread in the hospital that infections from various sources are still all of one type. In either case the aim must be to get rid of the source, or sources, of infection—either the single dangerous carrier or the widespread dangerous strain.

153. It is in this situation that a search for carriers ought to be made. Such a search should be confined to the persons working in the place which the epidemiological investigation suggests to be important; and it should include a search for minor infected lesions as well as healthy carrier sites. Type identification will be needed to discover which of the staphylococcal carriers, if any, is harbouring the epidemic type. Antibiotic (especially penicillin) sensitivity may be a useful screening test for this purpose, but should not be relied on too far. In the ward, patients—either healthy carriers or with some subclinical infection—need to be considered as well as staff.

154. A fair number of epidemics have been described, both in surgical units and maternity hospitals, in which a single person was apparently directly responsible for a large number of cases of infection. In such circumstances the epidemic can be terminated by exclusion and treatment of the person responsible.

155. Where it seems that the dominance of one type of staphylococcus is due to the invasiveness or communicability of the organism rather than to dispersal from one source, the attempt has to be made to eliminate all sources of that strain. All cases of sepsis (including chest, intestinal and urinary infections) due to the epidemic type should be isolated. All cases of subclinical infection and all carriers of the type should be treated vigorously to render them non-infective; in the face of a serious epidemic patients should be isolated and staff excluded from duty until they are free from infection. Bedclothes etc. from infected patients should be sterilized.

156. Nasal carriage of *Staph. aureus* can usually be controlled by local application of creams containing such antibiotics as neomycin, bacitracin and gramicidin, or chlorhexidine. For skin carriage, chlorhexidine cream or hexachlorophene-containing soaps are probably useful.

157. When a particular staphylococcus has been prevalent in a ward for any length of time, contamination of persons and things may be very widespread and further infection may not be controlled by the measures just listed. It may then be necessary to empty the ward of patients to permit more thorough disinfection. This should comprise disinfection of all bedding, curtains and other fabrics, and washing of walls, furniture and fixtures with disinfectant, with or without fumigation with formaldehyde vapour. The ward should be reopened only with close bacteriological surveillance of patients and staff to ensure that no carriers or persons infected with the epidemic type are readmitted. The disturbance caused by these measures emphasizes the importance of detecting and dealing with outbreaks at as early a stage as possible.

VII. ADMINISTRATIVE CONSIDERATIONS

158. The administration of schemes of control of hospital infection involves both internal relations and liaison with outside bodies. This section sets out recommendations for the distribution of functions and the channels of communication.

CONTROL OF INFECTION OFFICER

159. Within the hospital it is essential to have one person responsible for reviewing information on the incidence of sepsis, and co-ordinating preventive measures. The choice of this Control of Infection Officer should be carefully considered because the success of any scheme of control will largely depend on him. Nomination could well be made by the Control of Infection Committee (see below) with the approval of the Medical Staff Committee.

160. The Control of Infection Officer must be in a position to advise in his own right and should therefore be a senior member of the medical staff. The hospital bacteriologist is often the person of choice, but clinicians might well be encouraged to take close interest in this work.

161. The functions of the Control of Infection Officer are to keep the responsible members of the hospital staff informed of the incidence of sepsis,

to advise preventive measures and to check their efficacy. His information and advice may be given informally or at meetings of the Medical Staff Committee or the Control of Infection Committee. He could, with advantage, help in the training of staff.

BACTERIOLOGIST

162. The hospital bacteriologist (or pathologist) should undertake responsibility for checking the efficacy of sterilisation and disinfection.

MATRON

163. The matron should ensure adequate training and supervision of nursing staff and, in consultation with the domestic supervisor if any, of domestic staff. Training may be delegated to a senior sister or sister tutor. The Control of Infection Officer may be able to assist.

164. The matron should be responsible for the co-ordination of requests by members of the nursing staff for equipment or facilities and should bring these requests to the notice of the responsible hospital officers or, if necessary, to the Control of Infection Committee, House Committee or Hospital Management Committee. It is desirable to hold sisters' meetings at regular intervals and, at these meetings, problems of hospital infection could be discussed.

WARD SISTER

165. The ward sister is responsible for maintaining the ward sepsis register and informing the matron and responsible medical staff. She should draw the attention of the matron or responsible medical staff to any lack of necessary facilities and ensure the strict adherence of all the staff in the ward to the measures recommended for the prevention of infection.

HOSPITAL SECRETARY

166. The hospital secretary should arrange adequate training and supervision of engineering and maintenance staff, including those operating disinfectors or incinerators, laundry staff, catering staff and other grades (apart from nursing or domestic). These functions may be delegated to other officers, e.g. hospital engineer, laundry supervisor or catering officer with assistance from the Control of Infection Officer.

CONTROL OF INFECTION COMMITTEE

167. It is recommended that this committee should be composed of:

- (a) Clinical members nominated by the Medical Staff Committee, including the Control of Infection Officer and the consultant bacteriologist or hospital pathologist, if one of these is not also the Control of Infection Officer;
- (b) the Matron and at least one other senior member of the nursing staff, including a sister tutor if the hospital is a training school for nurses.
- (c) The Hospital Secretary.

It is highly desirable that the Medical Officer of Health of the local sanitary district should be represented on this committee.

168. The Control of Infection Committee should hold regular meetings to review the hospital's sepsis record. Extraordinary meetings should be convened whenever the level of sepsis is giving rise to concern, in order to advise on special measures to be adopted in the face of an outbreak.

MEDICAL STAFF COMMITTEE

169. The Control of Infection Officer should be a member of the Medical Staff Committee.

HOUSE COMMITTEE

170. In some hospital groups certain matters relating to control of infection may conveniently be raised at meetings of a House Committee and referred, if necessary, either to the Control of Infection Committee or to the Hospital Management Committee.

HOSPITAL MANAGEMENT COMMITTEE

171. Members of a Hospital Management Committee should be aware that staphylococcal infection is an important problem in many hospitals and that outbreaks may occur in spite of precautions that have appeared adequate in the past. The task of hospital officers in maintaining preventive measures is facilitated by understanding on the part of managements of some of the technical difficulties involved. It is particularly desirable to avoid an atmosphere of seeking to lay blame or find scapegoats for any untoward incident. Difficulties can often be traced to inadequate facilities, training or supervision rather than to neglect of duties.

172. It is part of the function of a Hospital Management Committee to ensure that adequate arrangements are made to control hospital infection. These arrangements should include the setting-up of a Control of Infection Committee and the appointment of a Control of Infection Officer.

BOARD OF GOVERNORS OF A TEACHING HOSPITAL

173. The remarks contained in the paragraph on the Hospital Management Committee apply also to the Board of Governors of a Teaching Hospital. The presence of medical students creates additional problems in a teaching hospital. It is recommended that instruction in the prevention of infection and the practice of aseptic techniques should be given at an early stage of clinical training. Medical students should be required to conform to the standards expected of other members of the hospital staff. The circumstances in which students attend surgical operations and the accommodation to be provided for them should be considered by the Control of Infection Committee.

LIAISON WITH OUTSIDE BODIES

174. The Control of Infection Officer should exchange information, when indicated, with professional colleagues outside his hospital, namely:—the Senior Administrative Medical Officer of the Regional Hospital Board, the Medical

Officer of Health, general medical practitioners, either individually or through the Local Medical Committee, the director of the appropriate Public Health Laboratory and medical officers of the Ministry of Health.

175. Formal communications, when necessary, should be made by the Hospital Management Committee or Board of Governors to the Regional Hospital Board, the Medical Officer of Health or the Local Executive Council. During outbreaks it is essential to keep the Regional Hospital Board informed of progress, with a general statement of the action taken.

176. The importance of adequate liaison, both within the hospital and outside it, cannot be too strongly emphasized. The control of staphylococcal disease is not merely the province of a particular department of a hospital but one which involves the hospital as a whole and the community in which it is situated. It is not suggested that any statutory obligation to transfer detailed information should be placed on a hospital authority; any such requirement is superfluous when adequate liaison has been established. It is by the free interchange of significant information, rather than by the obligatory notification of specific items, that genuine co-operation can flourish. The need to be kept informed should be felt as much by hospital authorities as by outside bodies. General practitioners and Medical Officers of Health can assist by informing their hospital colleagues of infections among patients, both before admission and after discharge.

177. The peculiar difficulties of ascertainment of the incidence of breast abscesses in nursing mothers makes this a subject on which close liaison between hospital authorities, general practitioners and public health departments is particularly desirable. It is suggested that, in order to obtain more reliable statistical information on this matter, voluntary notification of puerperal or post-puerperal staphylococcal disease in mothers and, possibly, infants might be considered as an experiment in a trial area.

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APPENDIX I

RULES FOR ISOLATION NURSING

(Based on recommendations contained in Appendix B of Medical Research Council Memorandum No. 11, "The Control of Cross Infection in Hospitals", and Memoranda Nos. N.P.I. and N.P.III of the Standing Nursing Advisory Committee's "Manual of Nursing Procedures".)

The efficacy of isolation nursing in the prevention of hospital infections depends on:

- (a) adequate accommodation
- (b) proper facilities for hand-washing and for the disposal of contaminated articles
- (c) efficient ventilation
- (d) strict observance of the rules by all members of the staff—nurses, doctors, students, physiotherapists and other ancillary workers.

Isolation nursing is likely to prove most effective where the patients concerned are accommodated in single rooms. On account of the risks from airborne infection it is likely to be less effective where the accommodation consists of cubicles or screened positions within a multi-bedded ward and least effective where there is no structural separation.

The following rules are intended to apply to patients isolated in single rooms or segregated in multi-bedded wards. The term "isolated area" will be used to denote either a single room or the space around the patient's bed in an open ward.

1. *Windows* and ventilators should normally be kept open.

2. *Doors* should normally be kept closed.

3. *Articles* needed by the patient, or needed for the patient's treatment, should be kept, as far as practicable, within the isolated area. When dressings have to be done, the equipment will usually have to be taken from the general ward stock, but it is important that everything brought out of the isolated area should be disinfected, or sent for destruction, without delay. For this reason dressing trays, if the ward has a steriliser large enough to deal with them, may be preferable to dressing trolleys. Destructible containers should be used for soiled dressings. Care should be taken in the disposal of urine and faeces. Urinals and bedpans should be disinfected without delay.

4. *Gowns* should be provided for each isolation bed and should be worn by the attendants at every examination or treatment of the patient. When not in use they should be hung on hooks within the isolated area. Clean gowns should be issued daily and the used ones removed for laundering and sterilisation.

5. *Masks* should be worn by all attendants on entering an isolated area and discarded on leaving.

6. *Attention to the patient*

Before entering the isolated area the attendant should bare the arms to the elbows and put on a clean mask.

Immediately after entering the isolated area the attendant should put on one of the gowns kept there, then wash the hands in soap and water and dry them.

After attending to the patient the attendant should remove the gown, hang it on the hook provided for it and again wash the hands. The mask should then be removed and discarded, care being taken to handle only the tapes.

7. *Patient's Notes*

The patient's notes and charts should be kept outside the isolated area.

8. *Cleaning*

A gown reserved for the use of the ward maid should be among those kept within the isolated area. Essential cleaning equipment should also be kept within the isolated area. Dusters should be damped with disinfectant solution before use and boiled after use. The floor should preferably be washed. The alternative to washing is damp-sweeping with a broom kept within the isolated area. (Oiled floors should be swept with dry brushes of medium hardness.)

9. *Terminal Disinfection*

After the patient's discharge all non-expendable articles within the isolated area, including the bed-linen, blankets, mattresses, pillows and cleaning equipment should be disinfected. The bed and other furniture, the floor and walls should be wiped with disinfectant solution and thoroughly cleansed.

APPENDIX II

RULES FOR THE PERFORMANCE OF WOUND DRESSINGS

(Modified from Appendix D of Medical Research Council
Memorandum No. 11, "The Control of Cross Infection in Hospitals")

General

The rules must be followed for both clean and infected wounds. When dressings are carried out in the ward, dusting, sweeping, bedmaking and unnecessary traffic should cease, and bed-curtains should be drawn, 15 minutes before wound dressings are begun. Only one wound should be uncovered at a time.

Dressings may be performed by one person working alone, or by a team of two persons (dresser and assistant). The latter has the advantage that the dressing trolley does not have to be set anew for each patient, although it ought to be reset after the dressing of a septic wound.

Rules for a single dresser

1. Wash the hands thoroughly and dry them on a clean towel.
2. Prepare dressing trolley, either using pre-packed complete dressing kits or collecting into dishes the necessary sterile forceps, scissors, dressings and lotions from the stock drums, etc.
3. Proceed to the bedside. Adjust the patient and the bedclothes. Remove the outer dressings, but leave the innermost dressing in place. Soiled material should be placed directly into a container in which it can be taken for sterilization or destruction.
4. Wash and dry the hands.
5. Carry out the dressing, using a strict no-touch technique. It may be useful to have a sterile towel available to place on the bed as a resting place for material. Cover and bandage the wound.
6. Adjust the bedclothes.
7. Discard surplus clean material for re-sterilization. Place instruments and bowls in sterilizer. Mop trolley-top with disinfectant.
8. Wash and dry hands.

Rules for a two-person team

The team comprises a 'dresser' who takes off the bandages and dressings, and attends to the toilet of the wounds, and an 'assistant' whose sole duty is to look after the trolley and pass clean things to the dresser.

Dresser

1. Wash and dry hands.
2. Arrange patient and bedclothing; take off and discard outer dressings.
3. Wash and dry hands.
4. Remove and discard inner dressing. Carry out wound toilet, using sterile forceps and strict no-touch technique.
5. Discard forceps and any contaminated material for re-sterilization.
6. Wash and dry hands.

Assistant

- Wash and dry hands.
- Collect necessary material from dressing kit or drums, bottles, etc. Prepare moistened swabs as needed.
- Supply dresser with all sterile material, using long-handled forceps (kept in disinfectant when not in use) which must never touch non-sterile material.
- In the case of a dressing on a septic wound, discard any surplus clean material on trolley top for re-sterilization.

Dressing rooms

Either of the two routines described may be used. In busy out-patient or casualty dressing rooms it may be possible for one trolley assistant to supply two dressers.

APPENDIX III

OPERATING THEATRE PRACTICES

This Appendix does not describe operating theatre customs, such as the wearing of sterile gowns and gloves, that are already accepted and universally practised. It is not, therefore, a complete guide to theatre practice and discipline. Its purpose is to re-assert the importance of valuable practices that are sometimes overlooked and to mention others whose importance has been emphasised by recent work.

Most of the suggestions made here are intended to reduce the number of airborne organisms in the theatre during an operation. If they are meticulously applied they will achieve this object.¹⁸ They are intended to apply to staff working in sterilising rooms as well as those in the actual operating room.

1. The theatre nursing staff should become as permanent a team as possible. Changes of staff for training purposes are essential but changes for other reasons should be avoided. It is particularly undesirable to supplement the theatre staff for each operation with a nurse from the patient's own ward.

2. During an operation there should be no more people in the theatre than is necessary. It is impossible to specify here a maximum safe number. A properly ventilated theatre can safely accommodate more people than one with a primitive ventilation system.

3. Some people are prolific dispersers of organisms from the skin and bathing temporarily reduces this dispersal. Ideally every member of the surgical and nursing team should bathe before each operating session but this may not often be practicable. Theatre units should be provided with showers or baths.

4. All persons who will be in the theatre during an operation should remove their outer clothes or uniform and put on freshly laundered cotton shirts and trousers, or frocks, and canvas or rubber shoes. This rule should apply to students, visitors, radiographers and other occasional staff as well as to regular members of the theatre team.

5. Everyone in the theatre should wear a cap covering the hair and a mask over the nose and mouth. Even though a mask may allow contaminated particles to escape round the sides, it does prevent large droplets of saliva from being projected into the wound or on to sterile equipment during speech.

6. Woollen blankets should not be taken into the theatre. In a well-heated theatre suite a sheet may be sufficient covering for the patient; but if extra warmth is needed a freshly laundered Turkish towelling blanket may be used.

7. The patient should be lifted on to the table and got into position for operation outside the theatre. This can usually be done in the anaesthetic room. The table is then pushed into the theatre with a minimum of fuss. After the operation the transfer from table to trolley or bed should be made outside the theatre. As well as reducing disturbance, this procedure renders the presence of a porter in the theatre unnecessary.

8. During the operation, movement in the theatre should be reduced to a minimum. A nurse crossing the room raises a cloud of airborne organisms and some of these may land in the wound or on sterile equipment. Nurses and orderlies often wander about when temporarily unoccupied; this can be discouraged by providing seats for them.

9. No one should enter or leave the theatre—still less the theatre suite—during an operation except for a very exceptional emergency. Often, up to 50 journeys are made between theatre and sterilising room during an operation. The equipment carried on these journeys should be got ready in the theatre before the operation starts. Special journeys should not be made to take out used equipment before the operation is completed. These changes of routine often reduce the number of unscrubbed nurses needed in the theatre during an operation.

10. Talking should be reduced to the necessary minimum.